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ABSTRACT

Reflections on the meaning and uses of science and observations about its implications in the study of learning disabilities are offered in this paper. The distinction between science and technology is examined and difficulties with society's absorption in pseudoscience or in science that has been oversimplified are discussed. The field of left and right brain research along with society's various reactions to it is cited as a case in point. Research on dyslexia and other forms of learning disability (LD) is reviewed and implications for intervention briefly noted. The importance of clinical scientific observation to progress in the field of learning disabilities is asserted and a personal approach to interviewing students with suspected LD is described. (CL)

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The Sense and the Necessity of the Sciences in Learning Disabilities

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A year ago when John Sikorski called to invite me to give this presentation, I was more than happy to acquiesce to a long-time friend who, like me, was originally from Detroit and whom I had come to know quite well as a fellow undergraduate major in psychology at the University of Michigan. John's hope was that I would address the issue of science and the scientific method and its importance in defining and serving individuals with learning disabilities. I was reminded of our undergraduate experience in Ann Arbor, where the Department of Psychology was quite strong, but like so many departments of psychology it was almost on the defensive in affirming that psychology was indeed a science. As a consequence, epistemology, which is the science of methods and validity of knowledge, was extremely strong there and formed a common thread through many of the undergraduate courses in psychology. That background served both of us well in medical school and later as clinicians, I in neurology and he in psychiatry. Both of us share a number of attitudes learned independently from our experiences with students and adults with unique learning styles.

What I would like to review with you this morning is my perception of what science is and perhaps what science is not. I especially hope to be able to comment on what constitutes the difference between science and technology. At that point I will digress into some scientific

observations with regard to aspects of learning disability that I think are particularly important today. Then I will mention some ways in which this careful scientific work has perhaps been taken too far afield from what the data and rational reflection would permit. Next, I shall comment about the unfortunate enthusiasm that we Americans have for what is best referred to as "pseudoscience," and why it is that such spurious science is appealing to so many people. Then I would like to review what constitutes clinical science and to what extent technology is required to perform investigations and test results in the clinical sciences. Finally, I hope to demonstrate why clinical science is essential if we are to have any appreciation for the reality of learning disabilities as a phenomenon and a human trait that challenges the flexibility of society. All of this could be a very dry and studious discussion, but I hope we can go through it in a pleasurable way, providing you with both sight and sound, and if I may speak with tongue in cheek, to stimulate your right as well as your left hemisphere. To achieve this, slides, including cartoons, will be used as illustrations for some of my points.

First, let me begin by dedicating this discussion about science to one of the greatest neurobehavioral scientists of all time, whose genius lay not only in the power of his thinking but also in his creativity. We all

mourn the untimely passing last November of Norman Geschwind, the James Jackson Putnam Professor of Neurology at the Harvard Medical School.

A dictionary definition of science shows that it is derived from the Latin scientia, which is defined as knowledge. One does science when one conducts systematic observations of phenomena for the purpose of discovering laws that govern those phenomena. Science itself is that body of knowledge that is accumulated by such investigation. The essential requirement is systematic observation. Now, those of us who are working with human behavior are engaging in a behavioral science, which is the interdisciplinary study of the behavior of man and lower animals for the purpose of understanding man as an individual and social being. Both definitions are from Dorland's Illustrated Medical Dictionary. Do they mean that science guarantees truth, wisdom, and the preservation of the American way? The answer is no.

Bertholt Brecht, in his Life of Galileo, pointed out that "the aim of science is not to open the door to everlasting wisdom, but to set a limit on everlasting error." Thus, science offers no guarantee of wisdom. Rather, it is a mechanism to decrease our risk of not realizing what is the truth. The appreciation of that which is true may be difficult because the issues are complex and

tax the human intellect or because, as humans, our biases derived from cultural experience may make the perception of what is true difficult.

If the act of doing science is to control for these biases, does that mean that there is no emotion in our pursuit of truth when using the scientific method? The answer is that science is not emotionless but indeed is a zealous, passionate pursuit. That emotional energy drives us to ask the questions which our intellect attempts to answer.

Yet, if one asked the average individual to describe science, most commonly the reply would refer to one of the products of science. But that is technology, and what technology produces are tools. Instrumentation is simply a tool that science may use but which is not guaranteed to be used in a scientific manner. That requires structuring of a situation with careful observations. Technology, then, is applied science, and, as illustrated in the slide, this great technological breakthrough provides great benefit to commuters: the cordless toaster.

Whether the portable toaster will be used to answer a question in a scientific manner remains to be seen. But whether it is a portable toaster, a highly sophisticated computer, or complex electrical equipment that provides a means of visualizing the anatomy or physiology of the brain,

the tools are no better than the people who use them. It is incumbent upon those who are using the tools to use them well. The tool is used best when the question to which the tool is being applied is asked carefully and is answerable.

Too commonly, instrumentation is equated with scientific thought, as illustrated in the cartoon. Like many I use, this is the work of Sidney Harris, published in The American Scientist and in such texts as Chicken Soup and Other Medical Matters and What's So Funny About Science? Here the Nobel Prize is not being awarded for the power of human thought but rather on the basis of technological advance.

I have already made some reference to the relationship between behavior and the brain. That certainly was the thrust of Dr. Geschwind's inquiry. We can look back a generation and see that Sigmund Freud, who started out as a neuroanatomist, was convinced that in the long run psychological processes would eventually become defined on a cellular basis. In his treatise "On Narcissism," he said, "...all our provisional ideas in psychology will presumably one day be based on an organic substructure." Because the definition of specific learning disabilities in Public Law 94-142 invokes the term "psychological processes," it may mean that our pursuit of the underlying mechanism of a specific learning disability will lie in the brain and the

way the cells of the brain look and relate to each other chemically and electrically.

How have science and technology served us thus far? Reasonably well, I would say. To say that science must always be correct is unrealistic. In the 19th century, investigation showed that language is lateralized to the left half of the brain and that discrete behaviors in the adult are localized to discrete regions of the surface of the brain. An extrapolation of that thesis was to feel one's propensity for these discrete functions literally by feeling the surface of the skull. That theory, which is associated with Gall, is known as phrenology and was, in its time, taken quite seriously. Since that time it has become apparent that the notion as proposed by Gall and his followers is not accurate. Nonetheless, no contemporary neuroscientist or clinician would dispute that a disproportionately small or large cranium is apt to be associated with central nervous system dysfunction or that great asymmetry of the head may suggest that a portion of the brain has not developed. It is the matter of the extreme to which the thesis is taken that results in its error.

Another difficulty is that we tend to popularize great notions and to simplify them so that we may comprehend ourselves and our environment better. Part of the problem

lies with the scientists themselves. As illustrated in the slide, where the treatment is mumbled by the physician or, as shown in the cartoon, is otherwise vaguely or inaccurately stated, too much may be left to the layman's imagination. But even well-stated ideas may be perversely translated.

An example of the latter is the valid observation, predicated on a series of elegant studies in animals and in humans who had had the two sides of the brain separated, that suggested that the two hemispheres were not functionally equal. One side, the left for most individuals, seemed especially adept at handling verbal tasks in a manner that was orderly, sequential, and definitional. The opposite, or right, side of the brain seemed, again for most individuals, to be especially adept at solving spatial problems and recreating mentally, and perhaps physically, in three dimensions. Thus when we needed a more holistic view of the world, this right side of the brain would be activated. Society overreacted to this carefully stated notion by using the shorthand of referring to unique aptitudes within individuals and then describing that individual as right- or left-brained. A cartoon from "Peanuts" demonstrates the point well.

Roger Sperry eloquently reiterated, in his Nobel laureate address of 1981, that the observations of

differential aptitudes between the hemispheres and between individuals spoke rather to the necessity that we as a society, particularly in the area of education, must respond to the biologic fact that differential aptitudes are to be expected. Although Sperry did not say it, when these differential aptitudes are extreme, individuals are apt to be called "handicapped." It would be better if we would accommodate ourselves to such individuals with differential curricula and testing techniques--without onerous labels.

I do not mean that there is no relationship between differential left and right brain function as this may relate especially to language-pertinent disabilities. A superb example is in the area of reading disability or dyslexia which Geschwind and his associates, particularly Albert Galaburda, have so elegantly demonstrated. Studies of dyslexics have confirmed, within five of five central nervous systems, a similar variation in the architecture of the surface of the brain. This work was facilitated with the support of the Orton Dyslexia Society and was initiated during my tenure as its president. This work suggests that a greater probability for reading failure exists when the surface area of a language-pertinent region of the temporal lobe is bilaterally equal rather than the more typical left-larger-than-right pattern. Furthermore, microscopic alterations in the arrangement of nerve cells are observed

predominantly in the left hemisphere. These cell changes may be the result of faulty cell migration in utero, and perhaps this altered cell migration is the result of testosterone influence.

The work of Geschwind and Galaburda has received international acclaim, but a characteristic that Norm possessed, which every good investigator should, is a sense of humor and the facility of not taking himself too seriously. I had hoped last November in Winston-Salem to show Norm a cartoon, which I think he would have enjoyed, that I found in the New Yorker of July 1983. In the cartoon a well-known physician told a barman that he had been a famous physician and with a colleague had enjoyed unusual success to the point that the story of his and the colleague's professional life was being made into a film and that the film would star Cheech and Chong.

The finding of these cellular changes, if they are eventually proved to be causal to reading disability, which is a common, though not the only, form of learning disability, does not mean that that learning disability is immutable and refractory to any change. Particularly early in life, flexibility appears to be the rule in the operation of the nervous system, and critical function may be taken up in new regions or new connections may develop in otherwise neglected areas. The possibility exists that these cell

changes can be prevented. But until one is certain what talent loss would result, caution is warranted. Indeed, as the cartoon suggests, there may be an advantage, although I suspect a limited one, in producing a society of Einsteins.

Another factor in the genesis of these changes appears to be one which is at least familial and perhaps may be under genetic influence. Perhaps that is why we see fathers and sons affected with dyslexia and certain other language-related disabilities. And why we may see, as the cartoon suggests, some women, in self-defense, going to a sperm bank to assure a quality product.

The fact that these are cartoons suggests that the issues around which they are drawn are indeed serious. Freud had once said that every bit of levity has its center of gravity. The issue of how we will come to understand how we are human and potentially possess the capability of adjusting our humanity is a frightening prospect for which, I would suggest at this stage, we are not yet prepared.

That someone like Sperry would be rewarded with the Nobel Prize puts additional pressure on individuals who work in this field to produce a product that captures the scientific and perhaps the public eye. It is perhaps this pressure for recognition that leads us to that unfortunate development of pseudo, or false, science. Among the characteristics of those who fall into the unfortunate trap

of inappropriately and inaccurately seeking "truth" is that they wrap themselves in the cloak of technology as well as with words and theories vaguely similar to those used in real science. Sweeping generalizations tend to be made which reflect the fact that the individual has not carefully defined the population about which the statement is being made. The desire to keep up with the latest and to make use of technology is satisfied, but unfortunately the need for a realistic appreciation of fact cannot be met. Too often the claim is made that more traditional clinical research scientists are somehow attempting to prevent a new, effective insight or treatment. For example, it is claimed we deny that a causal relationship exists between, say, allergy and a learning disorder. Furthermore, it is said that traditional science would not admit that the learning disorder can be "cured" by treating the apparent allergic state. But Geschwind pointed out in looking at the left-handed population and those with reading disability that each is more prevalent within the other. Furthermore, an allergy or immune illness may occur in higher frequency in either population. But that does not necessarily mean a causal relationship exists. Rather, each may be a reaction to what truly was the cause, in this instance, according to Geschwind, male hormone in utero. As a result, treating the allergy does nothing to the reading disability or

left-handedness. Similarly, treating left-handedness does nothing to reading disability or allergy. The old adage that "the buyer must beware" is true, unfortunately, for the public at large. Similarly, the old rule of debate still obtains that "the burden of proof lies upon the affirmative." That means that the person who makes a claim that he has a diagnostic tool or a treatment for a specific condition must prove it, and such proof must be replicated by others. Once more, all too often, we conjure up a notion when the word "science" is used that we must be dealing with some form of laboratory with instrumentation remote from the human condition. Although such may be the case (and it is required in certain studies of cell behavior), it may not be necessary and often is not necessary when it comes to trying to understand human behavior. Thus, the field of clinical science does exist. The term "clinical" communicates not cool, dispassionate, distanced observation, but rather the sort that occurs in a clinic: direct observation of a patient or client or student done in a way that is structured and systematic and that attempts to help us comprehend the behavior, why the behavior occurs, and what we may do to change the behavior.

I would submit that clinical scientific observation is essential if we are to make any progress in the field of learning disabilities. One of my concerns is that too often

parents, teachers, and many other professionals do not pay attention to their own observations. Not uncommonly, the description of a student's behavior by intelligent and experienced clinical educators tells me a great deal about what may be the nature of a student's classroom problem. The behavior of a child who is described as fretful, agitated, overly reactive, and thoroughly irascible throughout the day may not reflect a solitary area of educational underachievement but something more global and perhaps psychiatric. The behavior may reflect that problem which seems not uncommonly to interfere with educability and which is now called "attention deficit disorder" (ADD). On the other hand, the student who is agitated and behaves restlessly only when sitting in front of a book may be having trouble figuring out what is in the book and may have a selective reading problem. It is important also to recognize that the phenomenon of an attention deficit disorder may not be associated with educational underachievement. However, that condition commonly interferes with the social relationships of that student, which is an important concern. Adjustment of the environment, as well as consideration of medicinal management, are treatment options for ADD.

What Public Law 94-142 did, I suspect, was to frighten many good clinical educators from relying on their

observations and intuitions. Concern was raised that we must generate hard numbers that clearly are dispassionate but may also be erroneous. As this student is remarking in the cartoon, it is nothing but "tests, tests, tests," and there is no learning going on in the classroom. Of course, tests are used in the laboratory, and these scientists are dutifully carrying out written multiple-choice examinations of their laboratory rats. Just as it may seem silly to give rats written tests, it may be equally naive to think that written tests are the only measures of student learning.

The educator who daily works with the student in the classroom may be able to adjust his or her observations to when the student seems to experience difficulty and success. Likewise, those of us who are involved in the diagnostic mode outside the classroom may, in 45, 60, or 75 minutes in a structured but not upsetting interview, make a pretty fair assessment of the intellectual capacity, language skill, math skill, and social attributes of a student who may be struggling educationally.

A carefully and sensitively conducted interview done by an experienced clinician can yield information of diagnostic value. When I interview I also am interested in helping the student to learn something about himself or herself. I listen to the way the individual speaks and to whether or not the way I speak influences the way he or she

responds. I am not only interested in those features that are encompassed in the definition of a learning disability but also in those characteristics of the student that appear to me to be appropriate for his or her age and background in his or her social and emotional development and how well he or she has planned for the future. Just as there is more than one kind of disability that can occur in a learning disability, learning disability may coexist with other problems, including the possibility of emotional disorder. The following are some of the questions that are appropriate for my purposes, but they are never asked in a mechanical manner as if I were administering a "test":

Why am I seeing you?

Who or why did someone else want you seen?

What is a learning disability?

What are your easiest subjects? What are your hardest subjects? Most important for both of these: Why are they easy or difficult? Is it the class, the teacher, the text, or the subject matter?

How well do you do in speaking, understanding what is being said, and taking notes?

How good a reader are you (word, sentence, paragraph, short story, and book level)?

How well do you remember what you read? See? Hear?

Describe your writing, penmanship, spelling. How easily do you put your ideas down on paper?

Can you type? Are the mechanics difficult for you? Independent of that, if it is not too difficult, does this free your expression of ideas?

How do you think you do in math (calculations, thinking out a math problem, memorizing math facts, and using various formulas)? Do you know how to use a calculator? (It is fair to ask the student to show you!)

How do you do in a foreign language?

How do you do in art? Does it involve graphic work, 3-dimensional work, or art appreciation? What kind do you like and why?

What kind of mechanical skills, if any, do you have? Are these particularly tough for you?

Music: Do you sing? Do you play an instrument? Do you like listening to music? If so, what are your favorites? The social level of maturation of an adolescent is reflected in the answer.

What is your ideal study environment? What sound level do you want? How much light? Do you do better when you study with someone else around?

(That, of course, is important for some of our college-level students who must work well with their classmates in a study environment.)

Do you know how to work with computers? As the advertisement suggests, video games and computers are not equivalent tasks.

How do you do in sports? There are very few individuals who are great athletes in every sport. The individual who is a running back versus the individual who is a quarterback versus an end versus a defensive back has different talents, and that is why the running back plays a different position.

What are your outside interests and hobbies?

And now begin to analyze, as you have above, how you best perform in an examination situation: Do you like oral questions to which you give oral answers? If someone asks the question, do you write the answer? If you read the question, do you write the answer? Does it matter if it is timed or untimed? Which type is easiest for you: true-false, multiple-choice, short answer, or essay? Some individuals who have a history of reading disability do reasonably well on essay tests even though they say their penmanship is

slow. The multiple-choice question is very difficult for some of these students.

Under personal habits: Do you watch television? If so, what do you watch? The 14-year-old who appreciates the humor of M*A*S*H tells you something about his ability to perceive humor.

Who is your closest friend? What are his or her characteristics? What do the two of you do together?

What is there about you that makes you a good friend?

What do you look for in a friend?

Who is your closest family member?

Have you dated or gone steady (if they are the right age)?

Have you ever had problems with authorities?

Have you ever been involved in drug use? For those students who have unequivocal uniqueness in their learning style, I am quite frank with them that I am worried that drug exposure is particularly risky and should be avoided.

What are your career plans? And I have to make some assessment as to whether or not that is a good match with their apparent potential.

How well do you rest at night?

What is your best time of the day for study? Or classroom activities?

One question that all psychologists like: If you could be any animal in the world, what would you be and why?

The "locked in a library" question tells you what the students' free activities would consist of and how ingenious they are in getting out of locked places.

One question that tells us something about their social perception and awareness of the world at large: What is the biggest problem in the world? Students who say it's whether or not they are going to graduate from high school have told you a great deal about how far they can extend beyond themselves.

If clinical interviews, such as the one I have just reviewed, are mastered with a study of the actual output of the individual--that is, all along we are listening to how that individual speaks, responds to speech sounds, writes, spells, does mathematical calculations, and abstracts in a structured, systematic way--then we are doing clinical science. That takes time, just as it takes time for those in the basic research area to get their science done. Basic researchers need good clinical scientists around them,

including parents, educators, psychologists, speech and language clinicians, and physicians. The scientific method is available to us all. Every classroom is a laboratory. Every student is an experiment. And for part of the time the variables can be controlled. In the end, the basic researcher and clinical scientist can work together to define the various kinds of learning disabilities, why they exist, and how we may best manage them. The late Norman Geschwind demonstrated that creativity, thoughtfulness, and humor are valuable attributes. Let his example be a guide for us all.